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STATE OF CALIFORNIA
The Resources Agency

Department of Water Resources

BULLETIN No. 16-69

WEATHER MODIFICATION OPERATIONS IN CALIFORNIA

October 1, 1968 — September 30, 1969

JUNE 1970

NORMAN B. LIVERMORE, JR.
Secretary for Resources
The Resources Agency

RONALD REAGAN
Governor
State of California

WILLIAM R. GIANELLI
Director
Department of Water Resources

ABSTRACT

Within the reporting period, October 1, 1968, through September 30, 1969, nine licensees conducted eleven weather modification projects in California. During this period, all projects except the two fog dispersal projects dispersed some form of silver iodide to increase precipitation. The fog dispersal projects, conducted at the Sacramento Metropolitan and the Los Angeles International airports, used finely ground sodium chloride to increase runway visibility on foggy days. Heavy rains in January and February shut down many projects early.

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

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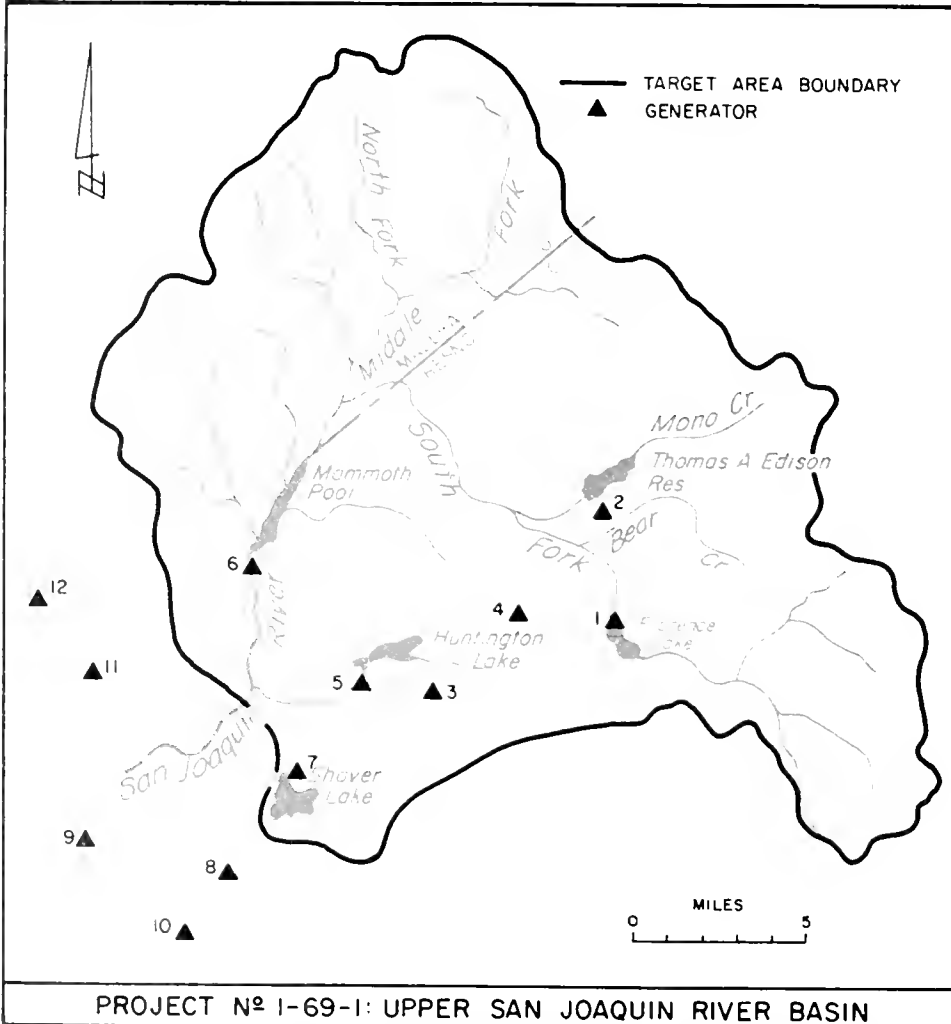
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Summary	Month					Total	
	Oct.	Nov.	Dec.	Jan.	Feb.		
Hours of Operation							
Generator							
No.	Location						
1	Florence	13.50	24.75	73.25	69.00	24.00	204.50
2	Vermilion	13.50	28.00	76.50	45.25	24.00	187.25
3	China Peak	31.50	57.00	106.75	44.00	36.50	275.75
4	Mt. Given	39.00	62.00	144.00	74.00	36.50	355.50
5	Huntington	36.25	62.00	133.75	74.00	36.50	342.50
6	Mammoth	38.50	61.75	147.25	65.75	0	313.25
7	Shaver	36.25	52.50	88.75	66.00	36.50	280.00
8	Pine Ridge	12.00	13.75	0	65.75	39.00	130.50
9	Auberry	12.00	13.75	97.50	66.50	40.25	230.00
10	Toll House	12.00	13.75	77.25	65.75	39.75	208.50
11	South Fork	11.75	13.75	99.25	19.50	0	144.25
12	Bass Lake	0	13.75	116.00	30.75	0	160.50
Total		256.25	416.75	1,160.25	686.25	313.00	2,832.50
Storms		3	6	4	4	1	18
Days of Seeding		4	8	13	7	3	35
AgI Used (grams)		1,537.5	2,500.5	6,961.5	4,117.5	1,878.0	16,995.0



PROJECT Nº 1-69-1: UPPER SAN JOAQUIN RIVER BASIN

WEATHER MODIFICATION OPERATIONS

Within the reporting period, October 1, 1968, through September 30, 1969, nine licensees conducted eleven weather modification projects in California. During this period, all projects except fog dispersal projects (Projects 33-69-1 and 33-69-2) dispersed some form of silver iodide (AgI) as the only nucleating agent. The fog dispersal projects used finely ground sodium chloride (NaCl) as the nucleating agent. Plate 1 summarizes the projects. Days of cloud seeding reported are the days on which seeding operations took place. Seeding did not necessarily occur during all hours of the day.

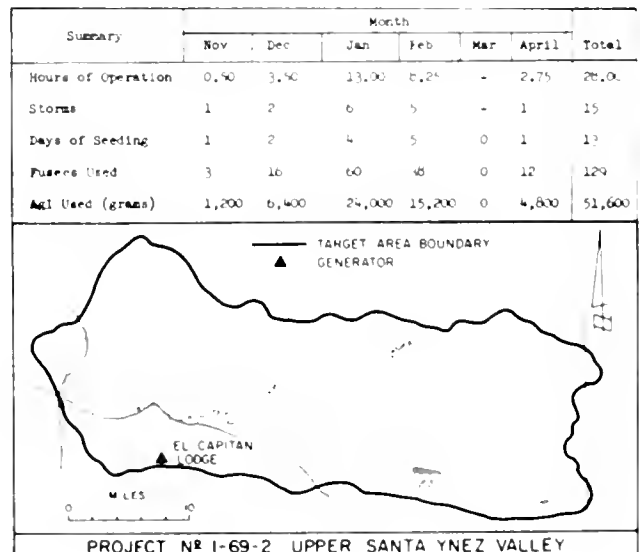
Because of heavy rains in January and February, many of the projects shut down ahead of schedule.

Neither the Sierra Cumulus Project of the Fresno State College Foundation nor the Southern Sierra Research Program of the Naval Weapons Center in China Lake operated during this reporting period. Each of these cumulus research projects had achieved its goal during the previous reporting period.

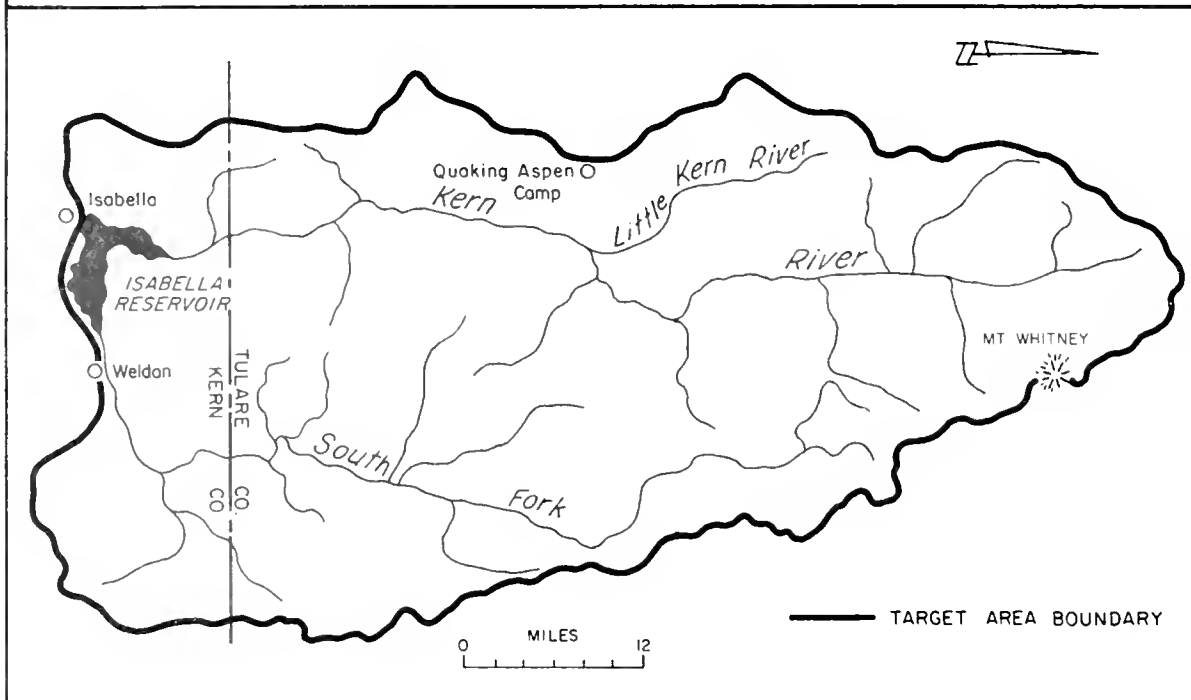
During this reporting period, the San Bernardino Valley Municipal Water District suspended operations (begun in 1960) of its Upper Santa Ana River Watershed Project so as to reorient the project to testing. The project will operate again in 1969-70.

Project No. 1-69-1: The Southern California Edison Company hired North American Weather Consultants to increase the snowpack in the upper San Joaquin River Basin above its Powerhouse No. 8. Twelve ground-based generators dispersed six grams of silver iodide per hour of operation.

Project No. 1-69-2: The Naval Weapons Center in China Lake hired North American Weather Consultants to test ground-based pyrotechnic devices set at El Capitan Lodge for cloud seeding in the San Rafael Mountains and the Santa Ynez Valley above Solvang. Each of 129 LW-83 fuses dispersed 400 grams of silver iodide during its 3.2-minute burn.



Summary	Month				Total
	Nov.	Dec.	Jan.	Feb.	
Hours of Flight Time	5.7	25.5	22.7	8.0	61.9
Storms	3	8	7	2	20
Flights	5	10	10	3	28
AgI Used (grams)	242	1,084	965	340	2,631



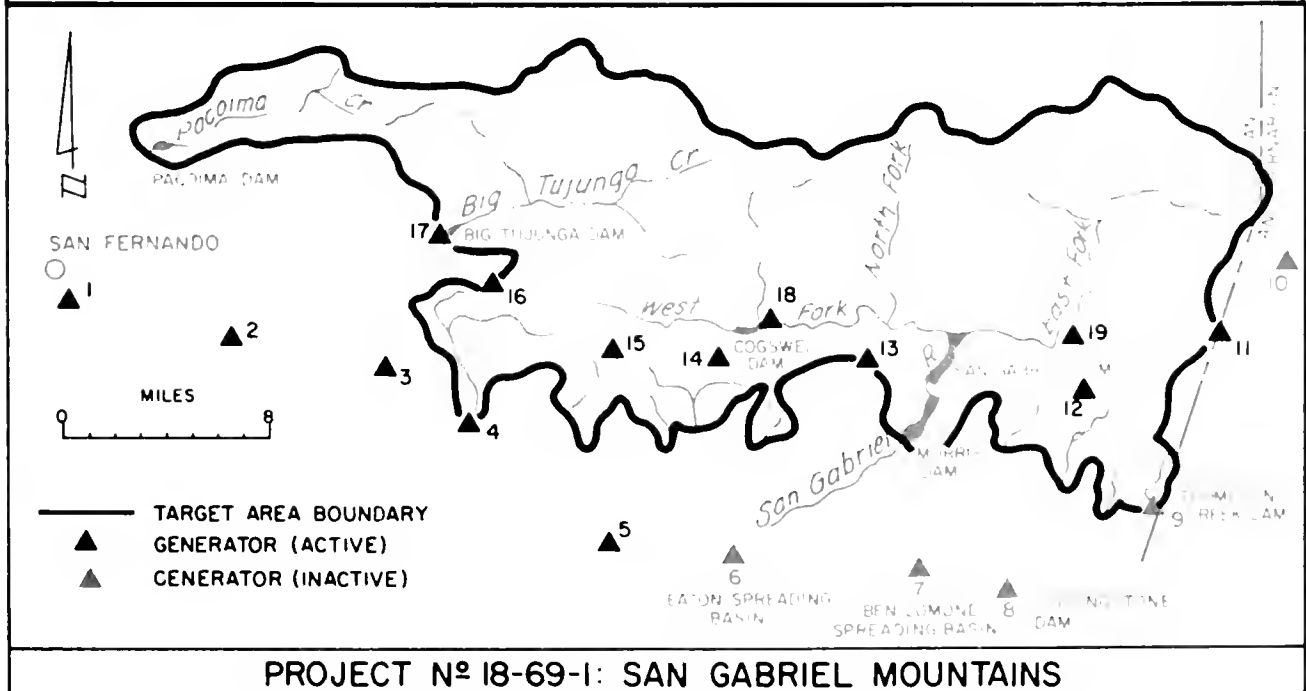
PROJECT N^o 12-69-1: UPPER KERN RIVER BASIN

Project No. 12-69-1: The Kern County Board of Supervisors hired Precipitation Control Company of California to increase precipitation and stream flow in the upper Kern River Basin. Aircraft, during 28 flights, dispersed silver iodide in smoke at the rate of $1\frac{1}{2}$ ounces (42.5 grams) per hour.

Project No. 18-69-1: The Los Angeles County Flood Control District sought to increase precipitation along the

southerly slopes of the San Gabriel Mountains above its many dams on the San Gabriel River, Big Tujunga Creek and Pacoima Creek. Fourteen ground-based generators dispersed a two percent solution of silver iodide (in acetone) into a propane flame at a rate of 6 grams per hour to produce 10^{12} to 10^{13} nuclei a second. The District moved generators from previous sites 6, 7, and 8 to present sites 10, 18, and 19 so as to avoid seeding the Pine Mountain burn area.

Summary		Month			Total												
		Nov.	Dec.	Jan.													
Hours of Operation																	
<table border="1"> <thead> <tr> <th colspan="2">Generator</th> <th></th> <th></th> <th></th> <th></th> </tr> <tr> <th>No.</th> <th>Location</th> <th></th> <th></th> <th></th> <th></th> </tr> </thead> </table>						Generator						No.	Location				
Generator																	
No.	Location																
1	Pacoima-Spreading Grounds	6.50	0	0	6.50												
2	LaTuna Debris Basin	0	0	16.75	16.75												
3	Pickens Patrol Station	7.50	0	29.50	37.00												
4	Devils Gate Dam	0	0	46.00	46.00												
5	Eaton Spreading Basin	0	0.75	14.25	15.00												
11	Mount Baldy Guard Station	2.00	0	12.25	14.25												
12	Tanbark Flat	6.00	6.50	38.75	51.25												
13	Pine Mountain	0	7.50	34.50	42.00												
14	Spring Camp	0	8.25	44.00	52.25												
15	Mount Wilson	8.00	3.75	16.25	28.00												
16	Red Box Ranger Station	7.25	4.00	34.25	45.50												
17	Big Tujunga Dam	7.25	11.00	37.00	55.25												
18	Cogswell Dam	6.75	11.25	46.75	64.75												
19	East Fork Ranger Station	8.50	3.00	50.50	62.00												
Total		59.75	56.00	420.75	536.50												
Storms		1	3	2	6												
Days of Seeding		1	3	5	9												
AgI Used (grams)		358	336	2,525	3,219												

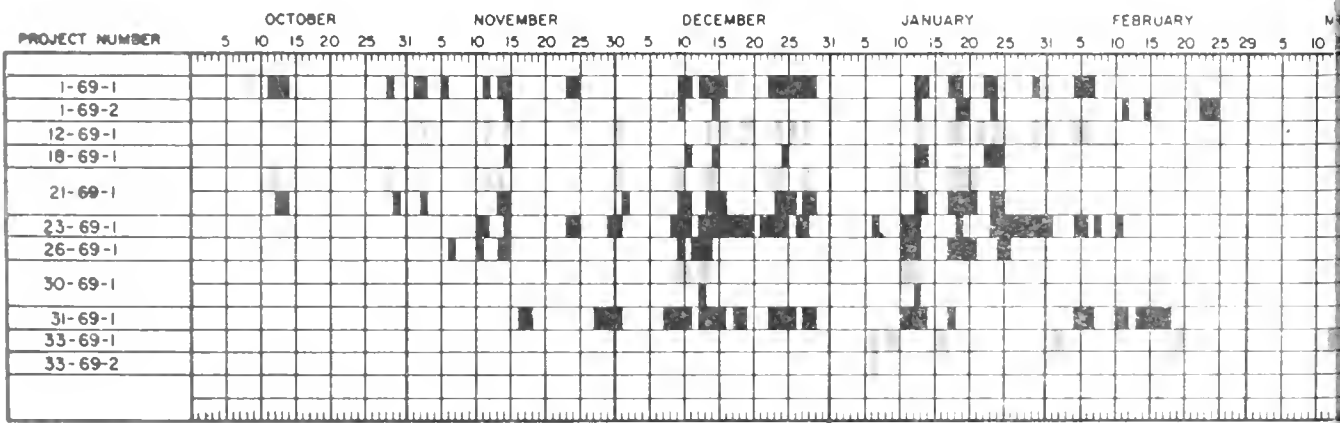


PROJECT Nº 18-69-1: SAN GABRIEL MOUNTAINS

LOCATION OF TARGET AREAS



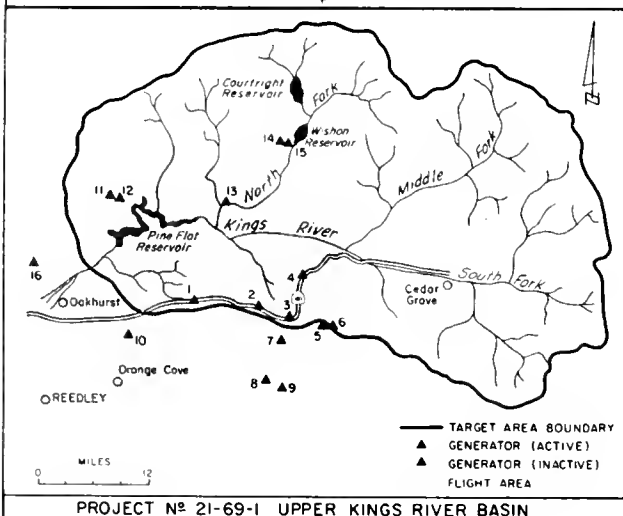
PROJECT No	YEAR		LICENSE	
	No	1968		1969
1-69-1	X	X	B... 61 Airport 4317	
26-69-1	X	X	A... Western Consul	
31-69-1	X	X	W... Regional Development Co... 92262	
30-69-1	X	X	... 92262	
1-69-1	X	X	... 93268	
21-69-1	X	X	... 90154	
12-69-1	X	X	... 43272	
1-69-2	X	X	... 9240	
18-69-1	X	X	... 94106	
33-69-2	X	X	... 104	
	X	X	... 2	



1968

GROUND BASED GENERATORS

Summary	Month				Total
	Oct.	Nov.	Dec.	Jan.	
Hours of Operation					
Generator					
No. 1	0	17.2	75.4	57.1	149.7
No. 2	0	16.4	50.4	81.3	148.1
No. 3	0	16.0	47.6	75.6	139.2
No. 4	6.2	25.2	37.5	101.8	170.7
No. 5	0	20.9	36.0	0	56.9
No. 6	0	7.7	0	25.7	33.4
No. 7	0	0	26.5	31.5	58.0
No. 8	0	0	37.8	24.0	61.8
No. 9	0	0	24.0	0	24.0
No. 10	0	0	47.7	10.0	57.7
No. 11	Not Operated				
No. 12	Not Operated				
No. 13	13.7	0	53.5	0	67.2
No. 14	13.7	0	23.5	0	37.2
No. 15	0	0	0	8.5	8.5
No. 16	Not Operated				
Sub Total	33.6	103.4	459.9	415.5	1,012.4
Aircraft	7.6	5.1	12.6	15.2	40.5
Mobile Unit	3.8	3.3	0	0	7.1
Total	45	111.8	472.5	430.7	1,060
Storms	2	3	7	4	16
Days of Seeding	5	5	12	8	30
Flights	4	3	7	7	21
AgI Used (grams)					
Generator	504	1,551	6,898.5	6,232.5	15,186
Aircraft	570	381	945	1,260	3,156
Mobile Unit	330	120	0	0	450
Total	1,404	2,052	7,843.5	7,492.5	18,792



Project No. 21-69-1: The Kings River Conservation District hired Atmospherics Incorporated to increase precipitation in the upper Kings River Basin above Pine Flat Dam. Thirteen ground-based generators dispersed a solution of silver iodide (in acetone) into a propane flame at a rate of 15 grams per hour. Aircraft, during 21 flights, used pyrotechnic devices to disperse silver iodide at a rate of 75 grams per hour (225 grams per hour during a 0.8

Summary	Month				Total
	Nov.	Dec.	Jan.	Feb.	
Hours of Operation					
Generator					
Burner Group					
No.	Location	West	South		
1	Christie Hill	X		28.6	146.9
2	Butt Mountain	X	X	44.3	133.1
3	Stover Mountain	X	X	0	178.1
4	Ohio Ridge	X	X	15.7	53.9
5	Keefer Ridge	X	X	44.3	200.8
6	Dyer Mountain	X	X	0	49.8
7	Feather River Meadows	X	X	0	200.8
8	Mud Creek Butte	X	X	0	107.9
Total				132.9	1,071.3
				669.6	188.5
				2,062.3	
Storms					
Days of Seeding					
AgI Used (grams)					
				7	6
				6	13
				3,375.66	27,211.02
				17,007.84	4,787.90
				52	382.42

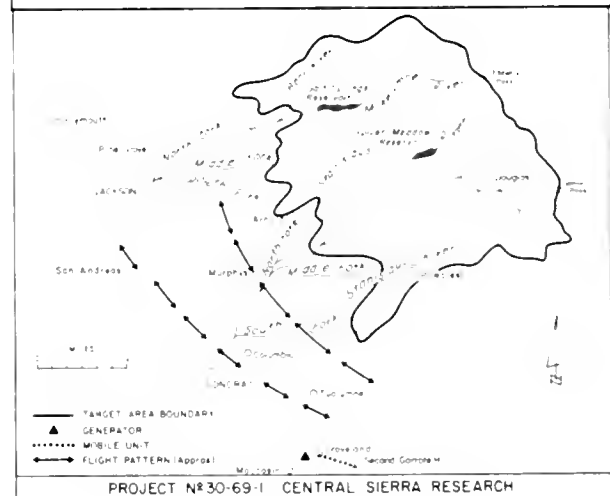
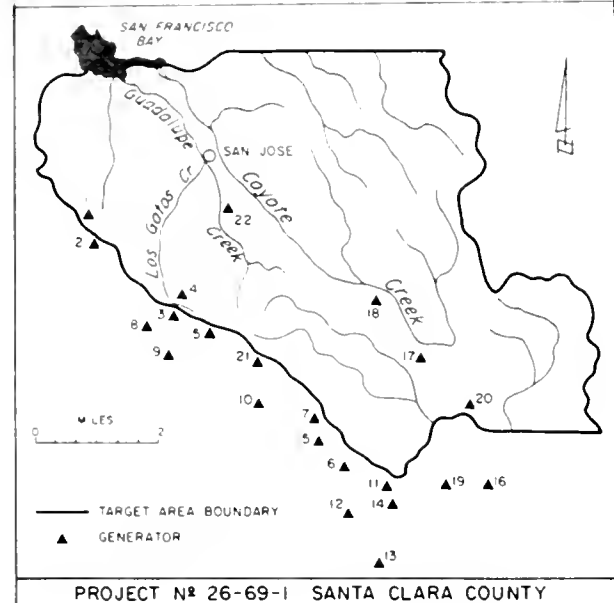
PROJECT No 23-69-1 LAKE ALMANOR

hour period in January). A mobile ground unit, traveling along Highway 180, used pyrotechnic devices to disperse silver iodide at a varying rate.

Project No. 23-69-1: The Pacific Gas and Electric Company sought both to increase high-level snowpack and subsequent dry season runoff and to study the effectiveness of cloud seeding in the North Fork Feather River drainage basin near Lake Almanor and Butt Valley and Mountain Meadows reservoirs. Eight high-elevation, radio-controlled generators burned a solution of silver and sodium iodide (in acetone) at the rate of 25.4 grams of silver iodide per hour. The generators operated as a group in each of two groups, West Burner and South Burner. Within each group, total hours of operation varied between generators because certain of them not always were operable.

Summary	Month			Total
	Dec.	Jan.	Mar.	
Hours of Operation				
No.	Generator Location			
1	Los Gatos (Sayline Boulevard)	6.7	10.7	42.3
2	Los Gatos (Sayline Boulevard)	11.7	16.0	82.1
3	Los Gatos (Sayline Boulevard)	16.5	11.7	84.9
4	Almaden Air Force Base	16.0	16.0	30.4
5	Los Gatos (Highland Way)	16.2	15.2	40.1
6	Watsonville (Riverside Road)	17.0	10.9	46.1
7	Watsonville (Bella Vista Lane)	16.7	23.9	81.0
8	Santa Cruz (Marten Avenue)	12.0	20.5	32.2
9	Santa Cruz (Old Soquel Road)	12.0	15.5	34.4
10	Corralitos (Corralitos Road)	12.7	15.5	32.8
11	San Juan Bautista	17.3	10.2	41.3
12	Salinas	10.6	5.7	0.0
13	Salinas	9.9	2.1	0.0
14	Salinas	10.8	0.7	0.0
15	Watsonville (Irwin Road)	0.0	0.0	0.0
16	Hollister	10.1	7.4	5.5
17	Gilroy	11.9	0.0	70.0
18	Morgan Hill	9.4	0.4	46.4
19	San Juan Bautista	16.5	7.4	61.3
20	Hollister	10.2	4.6	21.3
21	Watsonville (Burma Canyon Road)	1.2	22.0	42.7
22	Parlier Trailer County Communication	0.0	0.0	0.0
Totals		249.8	267.1	840.7
Storms		3	1	6
Days of Seeding		4	4	9
AgI Used (grams)		6,244	6,483	21,208

Summary	Month		
	Dec.	Jan.	Total
Hours of Operation			
Aircraft	5.75	8.75	14.50
Mobile Unit	.50	1.00	1.50
Total	6.25	9.75	16.00
Storms	3	1	5
Days of Seeding	5	3	8
Flights	6	5	11
AgI Used (grams)			
Aircraft	26,733	23,541	50,274
Mobile Unit	200	372	572
Total	26,933	23,913	50,846

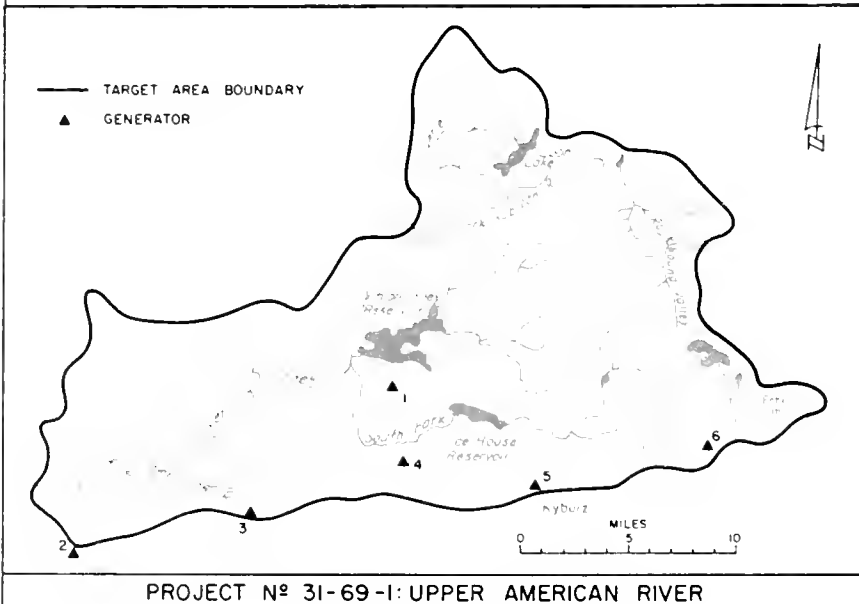


Project No. 26-69-1: Santa Clara County Flood Control and Water District sought to increase rainfall and subsequent water supply within Santa Clara County. Modified starfire ground generators dispersed silver iodide at the rate of 25 grams per hour.

Project No. 30-69-1: Fresno State College Foundation, Atmospheric Water Resources Research, experimented with weather modification in the watersheds of the Stanislaus and Mokelumne Rivers above an elevation of 6,000 feet. This Central Sierra Research (CENSARE) Project, a cooperative program, received

research assistance from both Meteorology Research, Inc., and the Desert Research Institute of the University of Nevada. It received both services and equipment from the Pacific Gas and Electric Company, the East Bay Municipal Utility District, and the Earth and Planetary Sciences Division of the Naval Weapons Center in China Lake. It received financial support from the United States Bureau of Reclamation, with whom it had a contract. During 11 flights, pyrotechnics (fusees), wing-mounted on aircraft, each burned 399 grams of silver iodide in 150 seconds to produce 2.5×10^{15} nuclei (measured at -12°C). Fixed and mobile ground flares each burned 28.6 grams of silver iodide in 45 seconds to produce 2.0×10^{15} nuclei (measured at -12°C).

Summary	Month				Total	
	Nov.	Dec.	Jan.	Feb.		
Hours of Operation						
Generator						
No.	Location					
1	Big Hill	0	0	0	0	
2	Camino	11.0	198.5	77.5	114.0	401.0
3	Fresh Pond	49.0	120.0	0	0	169.0
4	Log Deck (Peavine)	41.5	206.0	75.5	146.0	469.0
5	Kyburz	15.5	210.5	75.5	41.0	342.5
6	Strawberry	15.5	211.0	75.5	41.0	343.0
	Total	132.5	946.0	304.0	342.0	1,724.5
Storms		3	6	10	5	24
Days of Seeding		5	17	5	10	37
AgI Used (grams)		3,312.5	23,650.0	7,600.0	8,550.0	43,112.5



Project No. 31-69-1: The Sacramento Municipal Utility District hired the Weather Measure Corporation to increase snowpack in the Upper American River Basin. Six ground-based generators dispersed 43,112 grams of silver iodide at the rate of 25 grams per hour in an area north of U. S. Highway 50 between Camino and Echo Summit.

sodium chloride mixed with Cab-O-Sil (a commercial fused silica) to prevent its agglomeration in the hopper (capacity, 1,000 pounds). The pilot regulated flow by means of controls in the cockpit. The rate of flow he permitted depended upon the density of the fog, and varied from 40 to 150 pounds per minute.

Project No. 33-69-1: The Sacramento County Department of Airports hired the Environmental Services Operation of Edgerton, Germeshausen and Grier, Inc., to disperse fog on the runway and approach to Sacramento Metropolitan Airport. Aircraft dispersed milled

Project 33-69-2: The Los Angeles Board of Airport Commissioners hired the same firm to disperse fog on the runway and approach to Los Angeles International Airport. The materials dispersed and the method of dispersal were the same as for Sacramento Metropolitan Airport.

FOG DISPERSAL AT SACRAMENTO METROPOLITAN AND LOS ANGELES INTERNATIONAL AIRPORTS

NOTE: RVR Readings are given in feet. The first number is the ceiling, the second is the visibility, and the third is the RVR.

Project No.	Date		Seeding				Weather Conditions			Evaluation**			
	Month	Day	Time From	Material		Run Time	RVR Depth (feet)	Temperature	Dew Point	Wind Speed (knots)	Successful		Non-Made
				Grade	Pounds						Hours	Yes	
33-69-1	January	1	0625-0645	Fine	200	1	1000	49	34	-			X
	"	"	0631-0650	Fine	200	1	1700	43	34	-			X
	Drizzle over runway. During flights, RVR varied from 1,400 to 10,000 feet.												
	"	"	0643-0710	Fine	200	4	500	34	30	4-3	X		
	"	"	0605-0610	Fine	200	1	"	34	32	3-5	X		
	"	"	1200-1219	Fine	100	10	"	34	35	4	X		
	Between the start of the first and the end of the second flight, RVR increased from 1,000 to 2,000 feet. It increased further during Flight Three.												
	"	10	0731-0745	Fine	100	25	"	3	34	3-5	X		
	Hopper would not close. RVR unimproved.												
	"	16-17	0125-0125	200/Fine 200/200	20	17	175	36	37	4-6	X		
February	"	1	0614-0711	200	1000	30	205	36	36	3-7	X		
	"	"	1005-1029	Fine	400	10	600	41	36	4	X		
	"	"	2211-2234	200/Fine 200/200	20	5	600	44	43	5-7	X		
	Although RVR increased slightly during the first and rapidly during the third flight, winds carried more fog into the area.												
	"	2	1005-1040	200	1000	10	10	44	44	10-12			X
RVR varied from 3,400 to 5,200 feet as flight began. The fog, which formed after sunrise, already was lifting.													
"	3	0610-0710	200	1000	10	12	36	36	6-8	X			
"	"	0740-0815	200	1000	10	10	36	36	6-7	X			
"	"	0840-0920	200	1000	10	"	39	39	6	X			
RVR, which varied from 1000 to 1600 feet during flights One and Two, exceeded 2,400 feet with Flight Three.													
"	20	0724-0755	200/Fine 500/500	10	8	1100	46	45	3-5	X			
"	"	0835-0915	Fine	400	50	8	600	47	44	6	X		
"	"	0952-1012	200/Fine 450/450	50	5	"	46	47	6	X			
Flight One, reversing a downtrend in RVR, attained an RVR of 3,000 feet by 11:14 a.m. Flights Two and Three sustained visibility.													
March	13	0645-0720	200/Fine 350/350	"	5	"	35	35	5	X			
"	"	0725-0754	200/Fine 350/350	"	8	"	36	36	5	X			
"	"	0842-0919	200	650	50	4	41	39	6	X			
Flight One increased RVR to 1,400 feet; Flight Two, to 2,000 feet (enabling five aircraft landings). Flight Three sustained that RVR.													
33-69-2	January	7	0602-0652	200	1300	50	8	"	"	4-3	X		
	Two planes, by 6:40 a.m., attained an RVR varying from 1,800 to 3,400 feet.												
	March	28	0503-0648	200	2400	40	23	600	54	53	4-6	X	
Three planes, reversing a downtrend in RVR, attained an RVR of 1,000 feet by 6:00 a.m., and one of 6,000 feet by 6:20 a.m. Offset seeding resolved problems of fog drift.													
"	30	0509-0700	200	3200	40	21	600	54	53	4-6	X		
Three planes attained a heavy drizzle by 6:05 a.m. and an RVR of 3,000 feet by 6:30 a.m. Offset seeding resolved problems of fog drift.													

*Grade 200: particle diameters range from 2 to 6 microns, with 60% of diameters between 6 and 24 microns.
 Grade Fine: Particle diameters range from 2 to 10 microns, with 65% of diameters between 10 and 25 microns.

**Successful Evaluation: RVR improved at least 1,000 feet (takeoff minimum).
 Unsuccessful Evaluation: RVR remains below 1,000 feet.
 No Evaluation: RVR already exceeds 2,400 feet, although seeding flight made through fog.

WATER YEAR PRECIPITATION OCTOBER 1, 1968 - SEPTEMBER 30, 1969

SCALE OF MILES
20 0 20 60

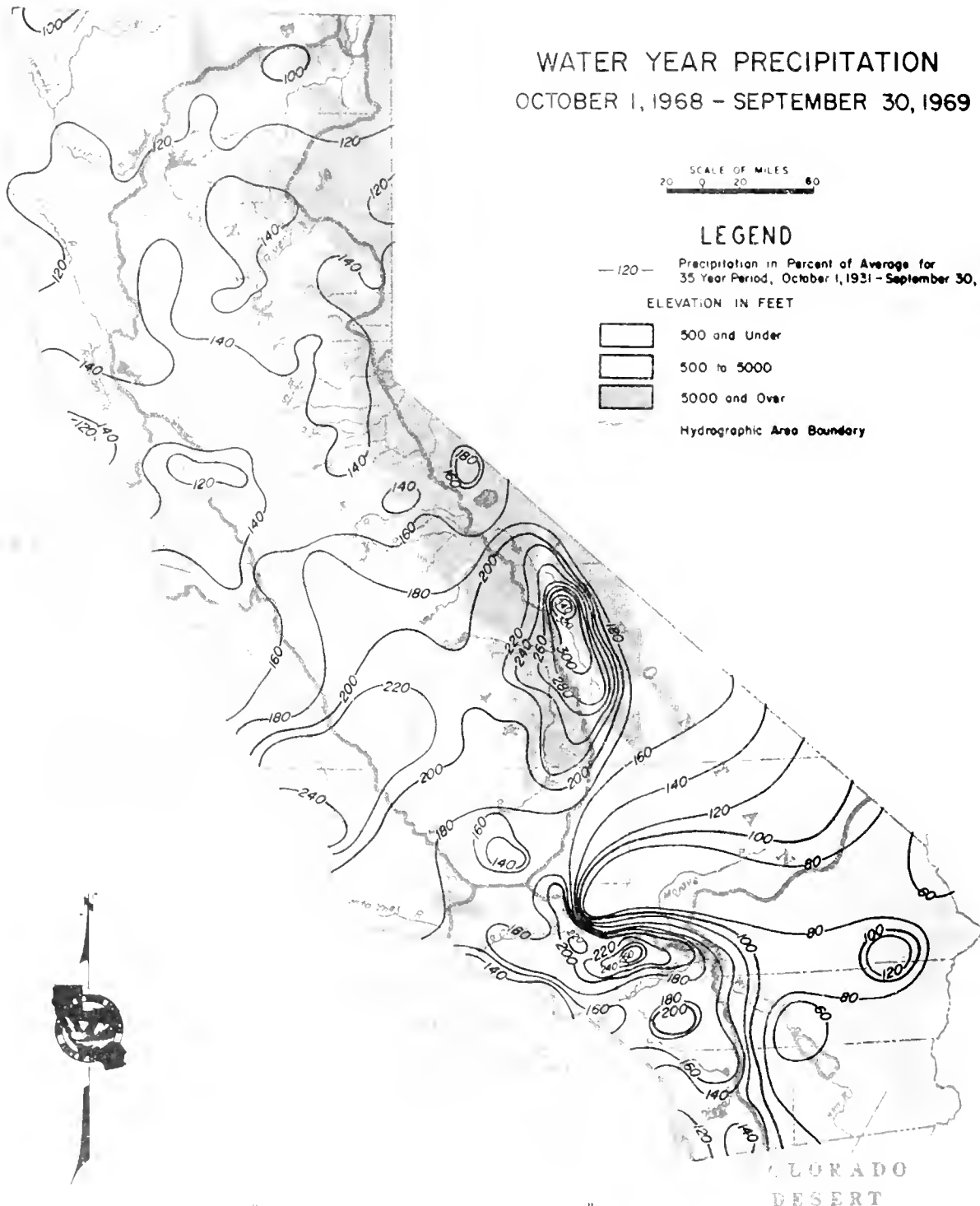
LEGEND

— 120 — Precipitation in Percent of Average for 35 Year Period, October 1, 1931 - September 30, 1965

ELEVATION IN FEET

- 500 and Under
- 500 to 5000
- 5000 and Over

--- Hydrographic Area Boundary



NOTE Bulletin No 120-69, "Water Conditions in California Fall Report", Dated October 1969, Provides Detailed Precipitation Data For The Water Year

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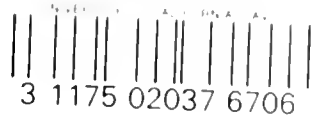
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